Ancillary Data Requirements

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Background

- **Accuracy requirements for soil moisture – retrieval error of 4% volumetric over surfaces with vegetation water contents up to 5 kg/m^2 (Hydros goal)**

- **Both static and dynamic ancillary data needed for accurate soil moisture retrieval**

- **Amount and type of ancillary data needed is dependent to some extent on choice of retrieval algorithm**

Microwave Emission Model

Surface Brightness Temperature:

$$T_{Bp} = T_s (1 - r_p) \exp(-\tau_c) + T_c (1 - \omega) [1 - \exp(-\tau_c)] [1 + r_p \exp(-\tau_c)]$$

where

- T_s and T_c are physical temperatures of the soil and vegetation canopy (K)
- r_p is the soil reflectivity [related to the emissivity by $e_p = (1 - r_p)$]
- τ_c is the vegetation opacity along the slant path where $\tau_c = b\, W_c \sec \theta$
  [W_c is the vegetation water content (kg/m^2) and b is a vegetation parameter]
- ω is the vegetation single scattering albedo
- soil roughness can be corrected as $r_{p\ smooth} = r_{p\ rough} / \exp(-h)$
- $r_{p\ smooth}$ is then related to the soil dielectric constant ε by the Fresnel equations
- soil moisture content m_v (% volumetric) is then estimated from the dielectric constant using dielectric models

<u>note</u>: if the air, vegetation, and near surface soil can be assumed to be in thermal equilibrium, then $T_c \approx T_s = T_{eff}$, the effective temperature over the microwave sampling depth

Microwave Model Inputs

All of the radiometer retrieval algorithms require some or all of the following inputs for retrieval at a point:

T_{Bc}	=	observed brightness temperature
T_{eff}	=	effective scene physical temperature (at 6 am)
θ	=	microwave incidence angle
τ_c	=	vegetation opacity (need b and W_c)
ω	=	vegetation single scattering albedo
h	=	roughness parameter
%S, %C	=	soil texture (% sand, % clay)

Land cover information

Masks / flags

Inputs to SM Retrieval Algorithms (1)

- **calibrated T_B w/ flags (RFI, precipitation, etc.)**
- **static ancillary data – do not change during mission**
  - -- **permanent masks (land / water, urban, forest, mountain)**
  - -- **grid cell topography (average elevation / slope)**
  - -- **soils information**
- **create master file of static ancillary data**
- **dynamic ancillary data – need periodic updates**
  - -- **seasonal land cover and roughness**
  - -- **vegetation parameters (W, b, ω)**
  - -- **effective soil temperature**
- **SMAP radar-derived information on transient water and frozen ground**

Inputs to SM Retrieval Algorithms (2)

- **Dynamic flags -- if set, they determine either specific aspects of processing (e.g. correction for transient water) or the quality of the retrieved SM (e.g., precipitation flag)**
  - **-- is ground frozen?**
  - **-- is it precipitating?**
  - **-- is ground covered with snow/ice?**
  - **-- is ground partially flooded?**
- **it may be beyond scope of SMAP project resources to set all flags – if so, alert users in metadata**
- **time resolution, time lag, accuracy, and ease of availability will all affect choice of primary ancillary source**
- **accuracy of ancillary data will be a critical factor in driving the overall soil moisture retrieval error budget**

SMAP Potential Ancillary Data Sources

PARAMETER	SOURCE	FREQUENCY
Surface Classification (incl. land/water mask)	NGA/SRTM NGDC GED v.2	land/water mask done once
Land Cover	VIIRS products MODIS data base	seasonally
Soil Texture	STATSGO & equiv. in US and Europe World soils map – Reynolds data bank	done once
Roughness (large area topography)	DEM (SRTM, USGS)	done once
Roughness (local microroughness)	Historical data base and/or SMAP radar	seasonally
Vegetation (b, W, τ, ω)	VIIRS products MODIS / historical phenology	updated every 1-2 weeks
Effective Soil Temperature	ECMWF forecast model NCEP forecast model GMAO model MW / VISIR LSTs as available	updated daily at overpass time
RFI flag	SMAP Aquarius / SMOS data base	done for each T_B
Other flags: Transient flooding Rain / precipitation Snow / ice Frozen ground	SMAP radar GPM or GCOM-W / NPOESS? SSMI or GCOM-W / NPOESS? SMAP radar or SSMI or GCOM-W / NPOESS?	(only some flags may be set within SMAP)

Summary

- **Multiple sources exist for each needed type of ancillary data**

  -- SMAP not critically dependent on any other mission for success

- **Similar types of ancillary data have routinely been accessed for other missions from sources both inside and outside of the US**

  -- there are no technical or cost concerns for SMAP ancillary data

- **Sensitivity studies provide useful information about potential error sources and their magnitudes**

  -- relationship between instrument errors and needed accuracies of ancillary data

- **Aquarius and SMOS missions will provide opportunity to further refine algorithm approach and error analyses**